PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Willamette Hatchery Oxygen Supplementation

BPA project number: 8816000
Contract renewal date (mm/yyyy): 9/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

Name	Dr. Harry Lorz
Mailing Address	ODFW, 7118 NE Vandenberg Ave.
City, ST Zip	Corvallis, OR 97330-9446
Phone	541-757-4186
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Email address	

NPPC Program Measure Number(s) which this project addresses
4.1; 7.2; 7.2.D

FWS/NMFS Biological Opinion Number(s) which this project addresses

Other planning document references

Short description
Determines survival of chinook salmon reared at various densities under conditions of oxygen supplementation.

Target species
Spring chinook salmon

Section 2. Sorting and evaluation

Subbasin
Willamette River Basin

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories

☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20550	Willamette Basin Mitigation Program Umbrella

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9000500	Umatilla Hatchery Monitoring	
8903500	Umatilla Hatchery Operations and Maintenance	
881603	Juvenile salmon migration	

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1989	Completion of hatchery modifications	Yes
1994	Completion of 4 experimental rearing years	Yes
1995	Through 1998: Analysis of water quality data	Yes

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Complete analysis of coded wire tag recoveries and conclude experiment		a: Summarize recoveries from all fisheries; b: Analyze recoveries by density; c: Analyze recoveries by raceway type
2	Complete manuscripts for publication		a: Effects of density and raceway type on metabolism; b: Water quality parameters of a surface water hatchery inflow; c: Effects of density and raceway type on survival of chinook salmon

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	9/1999	6/2000	Final report on study	Submission of report	94.00%
2	9/1999	6/2000	Mss submitted to journals	Publication in journals	6.00%
				Total	100.00%

Schedule constraints
None

Completion date
June 2000

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel		%0	
Fringe benefits		%0	
Supplies, materials, non-expendable property	Publication costs	%6	2,000
Operations & maintenance		%0	
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel		%0	
Indirect costs	35.5%	%2	710
Subcontractor	Dr. R.D. Ewing (Biotech	%92	30,600
Other		%0	
TOTAL BPA FY2000 BUDGET REQUEST			$33,310

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		%0	
		%0	
		%0	
		%0	
Total project cost (including BPA portion)			$33,310

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget				

Section 6. References

Watershed?	Reference
☐	
☐	
☐	
☐	

PART II - NARRATIVE

Section 7. Abstract

Spring chinook salmon were reared for four years at Willamette Hatchery, Oakridge, Oregon, under conditions of varying rearing density. Raceways with normal and triple rearing densities had oxygen supplemented to the raceways to achieve oxygen concentrations at the outflow similar to that of the inflow. In addition, a series of three Michigan-style raceways reared fish at triple rearing densities with oxygen supplementation. Growth, mortality, and length frequencies were determined at intervals throughout four replicate years of the experimental conditions. Water quality measurements were performed weekly throughout the rearing years. A continuous monitoring system was installed for measurements of oxygen, pH, and temperature at the inflows and outflows of the experimental raceways. Representative fish in the experimental raceways were marked with coded wire tags and released into the Willamette River.

Results from the water quality and growth analyses indicate that major differences in growth and feeding occurred between fish reared in raceways and those reared in Michigan raceways. Growth was always lower in the Michigan raceways and the fish were difficult to feed. Metabolism of the fish in the Michigan raceways was significantly higher than those reared at different densities. The lack of buffering capacity from the water inflow to the experimental raceways indicated that ammonia could not be a limiting factor to the densities achieved. Higher metabolic rates produced higher amounts of carbon dioxide, which acidified the water and converted ammonia to the nontoxic ionized form.

Preliminary results from adult returns suggest that survival may be inversely related to rearing density. Rearing juvenile chinook salmon in Michigan style raceways suppresses the percent survival to adulthood. Trucking the fish from Willamette Hatchery to the river below Dexter Rearing Ponds also decreases survival to adulthood. Final recoveries of adults were completed in fall 1998 and recovery of tags should be completed in 1999.

Section 8. Project description

a. Technical and/or scientific background

The project was designed to determine if spring chinook salmon could be reared at increased densities with oxygen supplementation without detrimental effects on the returns of adult salmon. The effects of oxygen supplementation and raceway design on water quality, rearing, and survival of chinook salmon were examined at Willamette Hatchery, Oakridge, Oregon. The rearing phase

was completed in 1994 and the recovery phase was completed in 1999. Only analysis of recovered coded-wire tags remains to complete the project.

b. Rationale and significance to Regional Programs

This project supported an interim goal of the Northwest Power Planning Council at the time of its inception to double the runs of salmon in the Columbia River from 2.5 million adults to 5.0 million adults. This was to be implemented through comprehensive management of both wild and hatchery fish. Hatchery practices were to be improved for greater output and survival. An increase in hatchery output through oxygen supplementation could be achieved without construction of additional hatcheries if the survival to adulthood was maintained. This project was funded to determine if oxygen supplementation could be used to increase production of chinook salmon from hatchery ponds without detriment to the adult survival.

c. Relationships to other projects

This project has been coordinated with a number of other BPA-funded projects, including Project Number 88-160-3 Migratory Characteristics of Spring Chinook Salmon in the Willamette River, Project Number 89-046, Smolt Quality Assessment of Spring Chinook Salmon, Project Number (unknown) Assessment of Bacterial Kidney Disease in Spring Chinook Salmon Stocks, and Project Number 9000500 Umatilla Hatchery Monitoring and Evaluation Project.

d. Project history (for ongoing projects)

The hypothesis to be tested was that the rearing capacity of chinook salmon in a surface water hatchery could be increased through use of supplemental oxygen without reduction in survival to adulthood. Initial activities concerned modification of existing raceways to the conformation of Michigan raceways, installation of contact columns for introducing oxygen, and modifications of the intake structure to protect the water supply. Experimental design called for spring chinook salmon being reared and released for four years. Water quality was to be monitored and growth of rearing fish measured. Duplicate raceways contained juvenile chinook salmon at normal rearing conditions without oxygen, fish reared at normal density with oxygen supplementation, fish reared at triple density with oxygen supplementation, and fish reared in a series of three Michigan raceways with oxygen supplementation. Representative samples of fish were tagged with coded-wire tags. Water quality was recorded weekly. During the first two rearing years, the water quality was performed manually. During the final two years, a continuous monitoring system was installed so that oxygen, temperature, and pH could be monitored from the inflow and outflow of a series of experimental ponds. Growth, size distribution, and mortality were followed throughout the rearing years. Analysis of water quality data in relation to rearing density and pond conformation have been accomplished and submitted to BPA. Returning adults will be collected and coded wire tags are being decoded for determination of survival of the various groups. Analysis of the survival data and completion of the final report will be accomplished by June 2000.

e. Proposal objectives

Overall Goal: To determine if chinook salmon can be reared at increased densities with oxygen supplementation without detrimental effects on the returns of adults. The project has achieved three conclusions to date: 1) With supplemental oxygen, chinook salmon juveniles can be reared at three times their normal rearing density without increases in disease or mortality; 2) Michigan-style raceways do not provide a healthy environment for rearing juvenile chinook salmon; and 3) Ammonia concentrations will not reach limiting levels with increased fish rearing densities in surface water which has low buffering capacity.

Two objectives remain for the project:

1) Analyze adult survival from coded-wire tags to determine the relationships between survival in the various experimental ponds.
2) Prepare manuscripts for publication of the results of this experiment in refereed journals.

f. Methods

The final phase of the project will require downloading information from the PMFC database of coded-wire tag recoveries and applying appropriate statistical methods to determine if differences in survival are present between different pond types and different densities. The complexity of the experiment lends itself best to nested analysis of variance, followed by Tukey's test for individual differences.

g. Facilities and equipment

Requires only a Pentium computer, a statistical program, and appropriate software and printers.

h. Budget

Total budget is $33,318

Section 9. Key personnel

Harry W. Lorz, Oregon Department of Fish and Wildlife
Richard D. Ewing, Biotech Research and Consulting, Inc.

Section 10. Information/technology transfer

Ten annual reports and eleven papers in refereed journals have resulted from this project to date. We anticipate two additional annual reports and three additional manuscripts by the completion of the project in June 2000. Information from this project has also been presented in four Northwest Fish Culture Conferences, a Western Region AFS meeting, an annual Columbia River smolt meeting, and a NATURES workshop.

Congratulations!